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SNOW-SURVEY SAMPLING GUIDE



**U. S. Department of Agriculture
Soil Conservation Service
Agriculture Handbook No. 169**

READY REFERENCE

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This Snow-Survey Sampling Guide was prepared to promote efficient and accurate snow surveying, to establish uniform sampling procedures, and to insure uniform results.

It is especially designed for those snow surveyors who have limited contact with the Snow Survey Supervisor and have not had the opportunity for a thorough training in snow sampling. It should be used by all snow surveyors as a reference and by supervisors as a training guide.

The manuscript was prepared by a committee composed of George Watt, Chairman, and Ashton R. Codd, both State Snow Survey Supervisors, Manes Barton, an Assistant State Snow Survey Supervisor, and R. A. Work, Head, Water Supply Forecasting Section, all of the Soil Conservation Service, in consultation with other snow-survey workers.

Felix Summers, Soil Conservation Service, Milwaukee, Wis., made the visual presentations after participating in snow-survey sampling in Montana and attending the West Wide Snow Survey Conference in Jackson, Wyo.

SNOW-SAMPLING PROCEDURE

Importance of accuracy

Accuracy is essential. A small error in snow sampling can produce a large error in the water-supply forecast. An error in measurement not only affects the current year's report but also the statistical analyses of the data for years to come.

Take special care to avoid error while reading the snow depths and tube weights. Be sure the core sample represents the full depth of the snow.

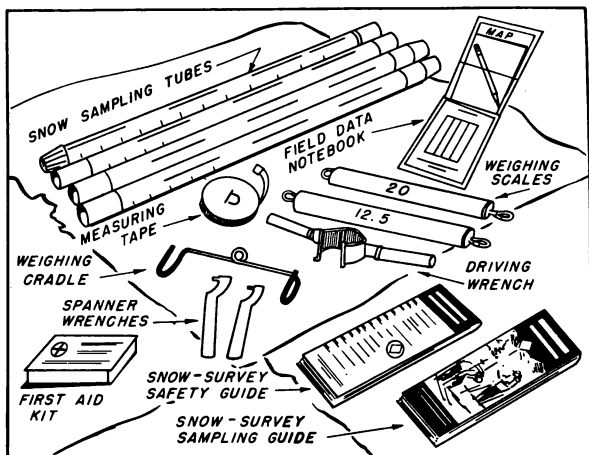
Care of sampler

Take good care of your sampling equipment. It will make the difference between a good survey and a poor one.

1. Transport the sampler carefully to avoid damage. The cost of this equipment is in excess of \$150.
2. Do not cling to the sampler while sampling on steep slopes.
3. Keep the sampler covered inside and out with a thin coating of wax or paraffin. The inside coating can be applied by pulling through a swab, then polishing with a dry cloth. This coating not only prevents corrosion but tends to keep the snow from adhering to the tube.
4. Be careful when sampling to avoid striking rock. Ice and rock feel and sound alike when struck.
5. Keep the cutter sharp and the orifice true to its original diameter. If the cutter is broken or badly worn, ask your supervisor for a replacement.

Check equipment

SNOW SAMPLING KIT



Before leaving headquarters, check all your equipment thoroughly.

1. See that tubes are properly waxed.
2. Make sure the coupling threads are clean and that you can screw all the tubes together without binding.
3. Check the sampling kit for the following items:
 - Sampling tubes that match
 - Spanner wrenches
 - Driving wrench (optional)
 - Field snow-data notebook
 - Pencil
 - Weighing scale and cradle
 - Snow-course map
 - Measuring tape
 - Snow-Survey Safety Guide
 - First-aid kit
 - Snow-Survey Sampling Guide

4. Check your oversnow traveling equipment for:

Goggles

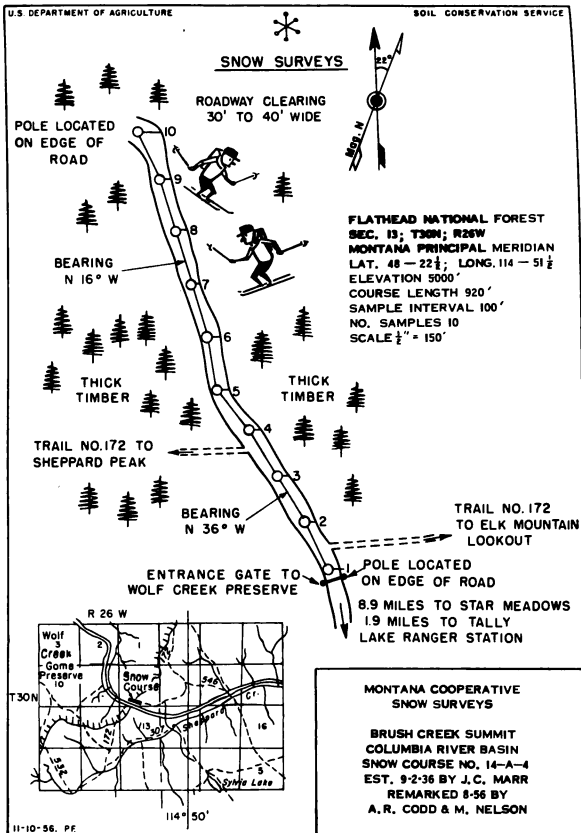
Skis—running surface, bindings, poles, climbers

Snowshoes—varnish coating, webbing, bindings

Oversnow vehicle—fuel and oil (see operating manual)

5. Check your own personal clothing and that of your companions. See Snow-Survey Safety Guide.

It is much easier to check these items at headquarters where replacements are available than at the snow course.



Step 1

Check the location sketch map of the snow course. Start sampling at sample point No. 1. Do not drive the snow machine on the snow course.



Step 2

Assemble sampling tube, screwing tubes together hand-tight (no wrenches). Make sure the numbers run consecutively throughout the entire length. Always use three or more sections of tubing unless the scale has been adjusted for light weights or accessory weights are added.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State MONTANA
Drainage Basin Columbia - Kootenai
Snow Course BRUSH CREEK SUMMIT
Party R. Funke - T. Triplett
Date Feb. 27, 1958.

[illegible]

*Show number or description as given on sketch map, *i. e.*, "Course No. 1," or "Major Course," or "N 5° E," etc.

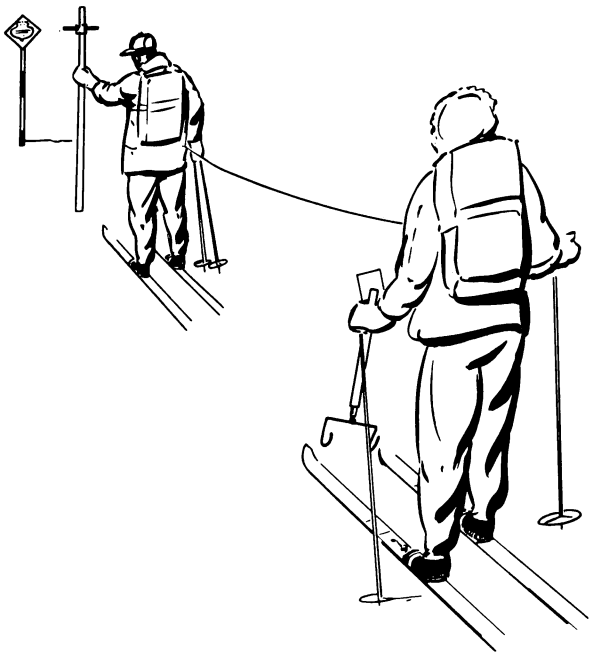
†Always start measurements for sampling from the *initial* point as shown by the sketch map of the course and follow the spacing for samples as indicated. Particular care should be taken to note any *irregular* spacing between samples.

No. 1 of 1 sheets. Comp. by _____ Checked by _____

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Step 3

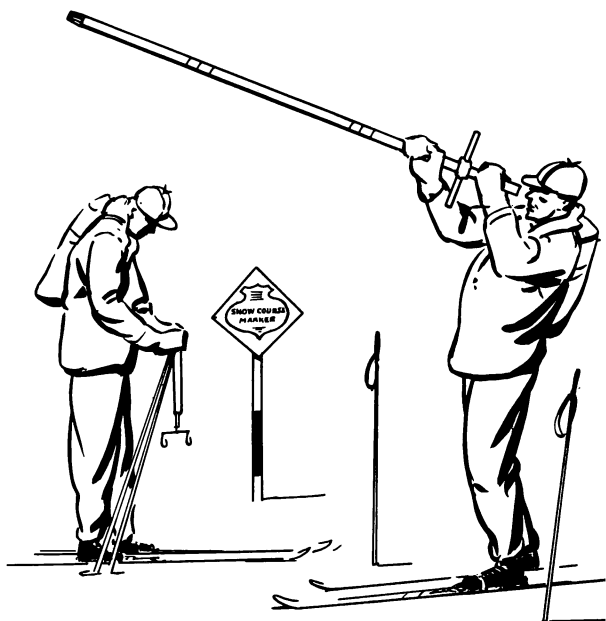
Fill in heading on snow-survey field note form.



Step 4

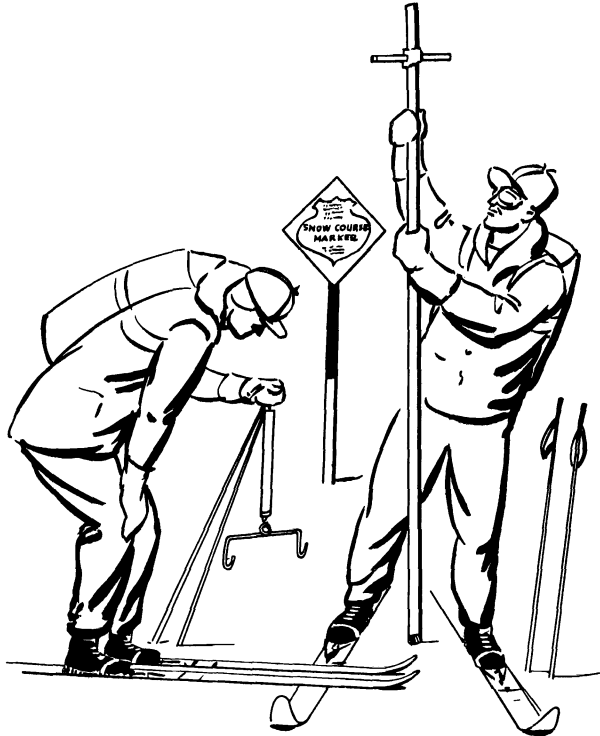
Find the sampling point by measuring the correct distance with a measuring tape following the direction as shown on the snow-course map.

One snow surveyor carries the sampling tube and head-end of tape. The second snow surveyor carries scale and notebook and holds the rear end of tape. The second man sights the head man on line of the course with the next marker.



Step 5

Before taking a sample, look through the tube to check for cleanliness. Hold the sampling tube away from your eye, cutter end up.



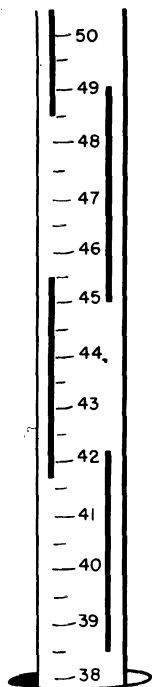
Step 6

Hold sampling tube vertically (cutter end down) and drive to ground surface. Use gloved hands to keep the tube cool (and make sampling easier). Be sure to drive through any ice layer on the ground surface.



Step 7

- Bend over and read the depth of snow. Call the depth reading to the recorder.

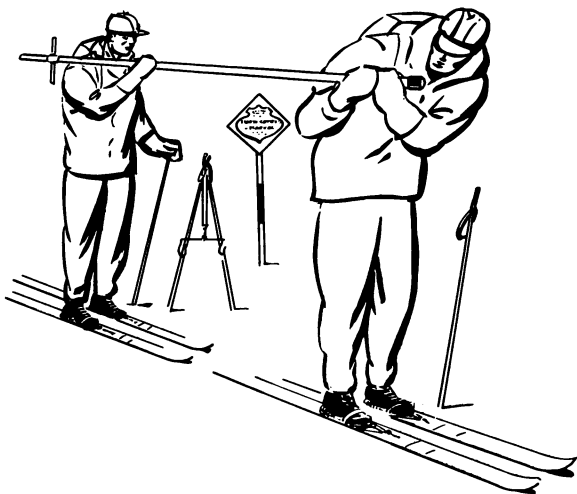


Step 8

Turn tube one turn to right to cut core loose from earth. Carefully raise tube, looking through slots to read core length.

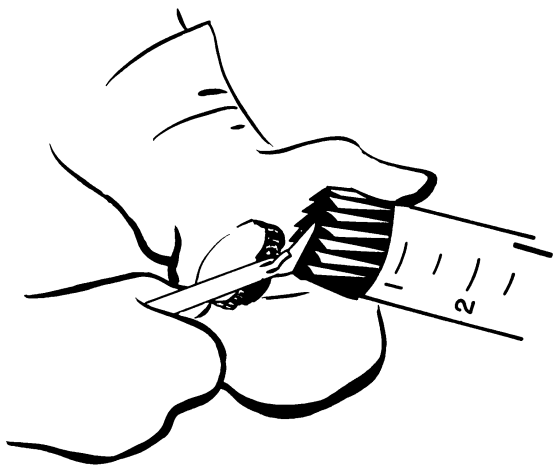
Call reading to the recorder.

Raise tube carefully out of snow.



Step 9

Inspect cutter end of tube for dirt or litter.



Step 10

Carefully remove soil and litter from the cutter and tube. Throw the debris or litter several feet away from sampling point. This prevents melt holes at the sampling point.

Give the recorder the adjustments in depth of snow and core length for distance driven into soil or litter.

Record data as shown on page 14.

SCS-708
(8-56)

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State MONTANA
Drainage Basin Columbia - Kootenai
Snow Course BRUSH CREEK SUMMIT
Party R. Funke - T. Triplett
Date Feb. 27, 1958.

*Description or Number of Course	†Sam- ple Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per- cent	Remarks (See reverse)
	1	38½						G.F. Damp.

Record depth of snow to nearest one-half inch (38½ inches, circled above).

If sampling point is bare, record "0" in snow-depth column. Do not move away from sampling point to find a spot with snow.

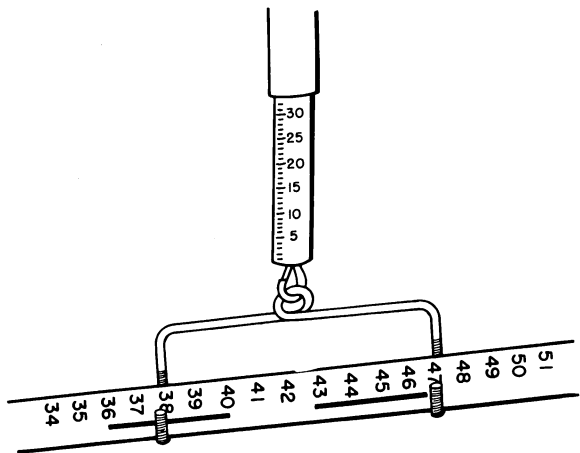
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FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State MONTANA
Drainage Basin Columbia - Kootenai
Snow Course BRUSH CREEK SUMMIT
Party R. Funke - T. Triplett
Date Feb. 27, 1958.

*Description or Number of Course	†Sam- ple Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per- cent	Remarks. (See reverse)
	1	38½	32					G.F. Damp.

Record length of core to nearest one-half inch (32 inches).



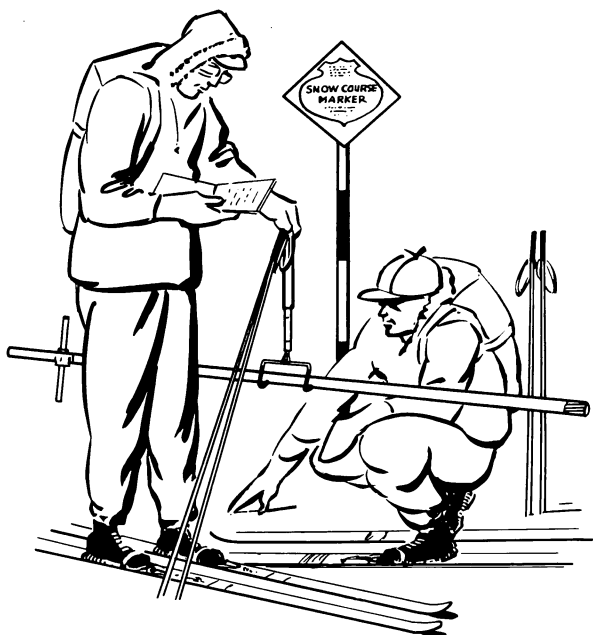
Step 11

Carefully balance the sampling tube containing the core on the weighing cradle. Second man supports top of ski pole if necessary.

Never hold the weighing scale with hand around barrel. Always suspend it like a pendulum.

If windy, point the tube into the wind.

When it is necessary to use a driving wrench, be sure to leave it attached when weighing the empty tube and when weighing the tube and core of snow. Record new empty weight.



Step 12

Read the weight of tube and core from the graduations on the scale.

Caution: Scales of 12½-foot-tube capacity have small graduations equal to 1 inch of water content. Scales of 20-foot-tube capacity have small graduations equal to 2 inches of water content. Water content means snow water equivalent.

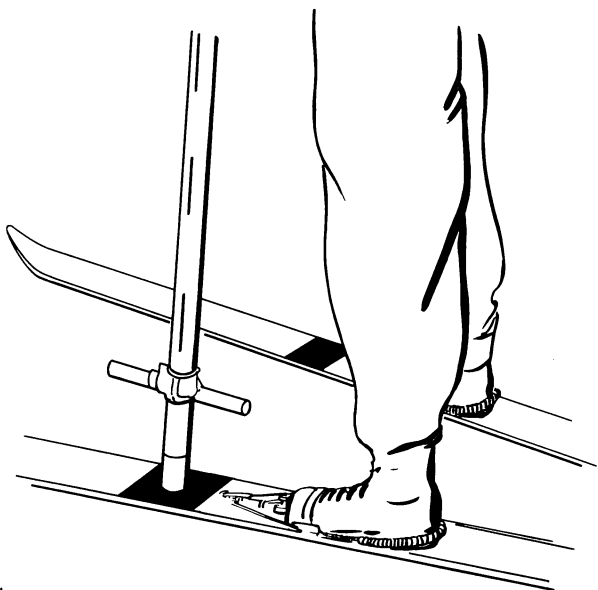
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State MONTANA
Drainage Basin Columbia - Kootenai
Snow Course BRUSH CREEK SUMMIT
Party R. Funke - T. Triplett
Date Feb. 27, 1958

*Description or Number of Course	†Sam- ple Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per- cent	Remarks (See reverse)
	1	38 $\frac{1}{2}$	32		33 $\frac{1}{2}$			G.F. Damp
	2							
	3							

Step 13

Record the weight of the tube and core to the nearest one-half inch (33 $\frac{1}{2}$ inches).



Step 14

Lift the tube from the cradle and turn cutter end up. Jar or tap against a rubber pad on the ski or snowshoe to slide the core out of the tube. Inspect the inside to see that all snow has been removed.

Note: A well waxed tube will aid materially in removing the core.



Step 15

Weigh the empty sampling tube. The empty weight of the tube must read greater than zero on the scale.

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FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State MONTANA
Drainage Basin Columbia-Kootenai
Snow Course BRUSH CREEK SUMMIT
Party R. Funke - T. Triplett
Date Feb. 27, 1958.

*Description or Number of Course	†Sam- ple Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per- cent	Remarks (See reverse)
	1	38½	32	(23)	33½			G.F. Damp

Step 16

Record the weight of the empty tube to the nearest one-half inch.

Check weight of the empty tube every third or fifth sample. Small particles of water or snow oftentimes cling to the inside and outside of the tube. Checking often will make the sampling more accurate.

If the driving wrench is put on or taken off during the sampling, a new empty weight must be obtained.

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UNITED STATES DEPARTMENT OF AGRICULTURE
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FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State MONTANA
Drainage Basin Columbia-Kootenai
Snow Course BRUSH CREEK SUMMIT
Party R. Funke T. Triplett
Date Feb. 27, 1958.

*Description or Number of Course	†Sam- ple Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per- cent	Remarks (See reverse)
	1	38½	32	23	33½	(10½)		G.F. Damp

Step 17

Subtract the weight of the empty tube from the weight of the tube and core to obtain the water content.

Record to the nearest one-half inch.

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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State MONTANA
Drainage Basin Columbia — Kootenai
Snow Course BRUSH CREEK SUMMIT
Party R. Funke — T. Triplett
Date Feb. 27, 1958

*Description or Number of Course	†Sam- ple Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per- cent	Remarks (See reverse)
	1	38 $\frac{1}{2}$	32	23	33 $\frac{1}{2}$	10 $\frac{1}{2}$	(27)	G.F. Damp
	2							
	3							

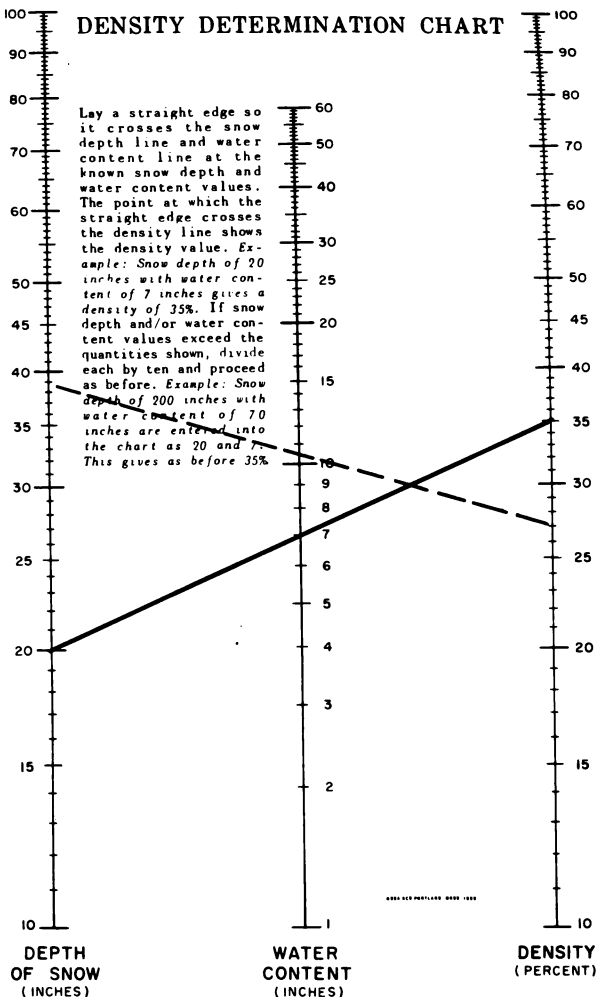
Step 18

Divide the water content by the depth of snow to obtain the density, or use the density-determination chart on page 22, or on the inside front cover of the snow-survey notebook SCS-708.

Ordinarily, the individual sample densities should not vary more than 10 percent. If difference is more, take another sample.

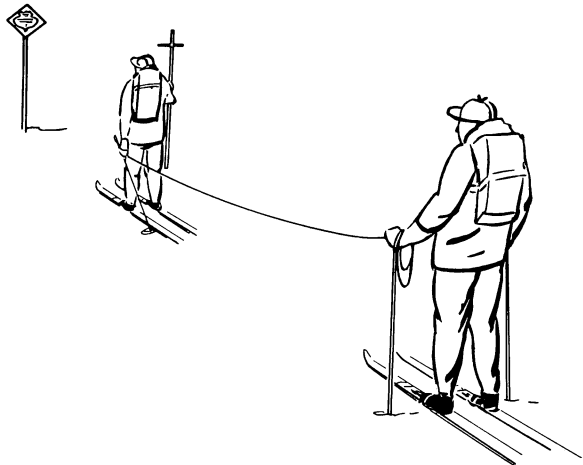
If the density is more than 60 percent, the snow is probably saturated from ponded water. Record the snow depth and determine the density at an adjacent point not affected by ponding.

DENSITY DETERMINATION CHART



GRAPH BY PORTLAND BRIDGE 1938

7-L-1536



Step 19

Measure and sample the remaining points shown on the snow-course map, following the procedures described in steps 4 through 18.



Step 20

Both snow surveyors inspect the notes. Add the figures in the depth-of-snow column and divide the total by the number of sampling points to get the average depth. Add the figures in the water-content column and divide the total by the number of sampling points to obtain the average water content.

Note: The number of sampling points includes those with zero depth. See sample of completed set of notes on pages 25 and 26. Fill in check list on back of field notes.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICEFEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State MONTANA
 Drainage Basin Columbia - Kootenai
 Snow Course BRUSH CREEK SUMMIT
 Party R. Funke - T. Triplett
 Date Feb. 27, 1958

*Description or Number of Course	†Sam- ple Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per- cent	Remarks (See reverse)
	1	38½	32	23	33½	10½	27	G.F. Damp.
	2	42½	37		35	12	28	" "
	3	40	37		33½	10½	26	" "
	4	43	36½	23	35	12	28	G.N.F. Damp.
	5	41½	37		34½	11½	28	" "
	6	45	42		36	13	29	Dry Dirt
	7	44	40	23	35½	12½	28	Damp Dirt
	8	38½	34½		34	11	29	Damp Needles
	9	44	39	*44	57½	13½	31	Wet Dirt
	10	38½	34½	44	55	11	29	Water
		=				=		
Total	(10)	415½				117½	28	
Average	(10)	41.6				11.8		
*Driving wrench added.								

*Show number or description as given on sketch map, i. e., "Course No. 1," or "Major Course," or "N 5° E," etc.

†Always start measurements for sampling from the *initial* point as shown by the sketch map of the course and follow the spacing for samples as indicated. Particular care should be taken to note any *irregular* spacing between samples.

No. 1 of 1 sheets. Comp. by R-F Checked by

NOTE.—Please fill in while in the field.

DATE OF SURVEY: Began 10:20 ^{a. m.} ~~p. m.~~ Ended 11:10 ^{a. m.} ~~p. m.~~

SAMPLING CONDITIONS

(Please check items descriptive of present conditions.)

Weather at Time of Sampling

..... Clear, Partly cloudy, Overcast, Raining,
☒ Snowing, Blowing, Freezing, Thawing.

Snow Conditions at Snow Course

Snow samples obtained with ☒ ease, moderate difficulty.*

Snow samples obtained with extreme difficulty.*

Ground under snow: ☒ frozen, not frozen,
 dry, ☒ damp, wet (saturated).

Ice layer on ground None. How thick? inches.

General Snow Conditions

1. What elevation is snow line generally? ft.
2. Is snow melting on north and east slopes? No
3. Is snow melting on south and west slopes? No
4. How many inches of new snow at snow course? 2 in.
5. Is there evidence of snowslides? None

General Stream-Flow Conditions

1. Are very small streams running? Yes No ☒
2. Are small streams bridged over by snow? Yes ☒ No
3. Are streams clear or muddy? (Check one) Clear ☒ Muddy

*Explain fully under remarks.

PRECIPITATION DATA

Month	Day	Year	Precipitation	Readings		Dipstick	Weight
			Current		Made by (check)		
			Previous				
Station name			Catch, inches		Scale number		
			After recharge				

REMARKS:

Truck, Roundtrip 58 Mi.
Sno Cat " 12 Mi.
Foot travel " 6 Mi.

Used 3 sections tubing.

Used driver at Samples 9 and 10.

USEFUL HINTS FOR SPECIAL CONDITIONS

Snow freezing in the tube

If the snow freezes in the point of the sampler and the entire core does not enter the tube, it is probably because the tube is above freezing temperature and the deep snow below freezing. The following steps will help you meet this difficulty:

1. Cool the tube by setting it in the shade or burying it in the snow.
2. Clean the tube thoroughly, then push the tube rapidly through the snow without stopping until you reach bottom.
3. Take the samples in the early morning or evening when the air temperature is cool.

If these precautions do not produce results, follow the procedure below:

1. Thrust the tube as deeply as possible without stopping.
2. Remove the tube carefully so as not to disturb the hole.
3. Weigh, and record the core length and weight.
4. Empty the tube and return it very carefully to the bottom of the hole.
5. Again thrust the tube deeper in the snow until it stops or you reach ground.
6. Repeat above as many times as necessary to reach the ground.

Record data as shown on sample note, page 32.

Sampling very shallow snow



When the snow water content is less than 2 inches of water, it is difficult to read the weighing scale accurately for single sampling points. To sample these shallow snows:

1. Take a sample at the sampling point.
2. Empty the core into a bucket or any container that can be tied to the weight scale. (If the empty container used is not heavy enough to record an empty weight on the scale, additional weights must be added. Sections of sampling tubes, driving wrenches, or anything handy can be used.)
3. Record the depth of snow and length of core on notes.
4. Weigh the container along with the necessary weights when all the sample cores have been accumulated.
5. Record this weight in the bottom of the column "weight of tube and core."
6. Empty snow from container. Weigh container and weights and record this figure at the bottom of the column "weight of empty tube."
7. Subtract weight of empty container from weight of container and core. Record the difference at the bottom of the column "water content." To obtain average water content on the snow course, divide total water content by total number of sampling points.

8. Total the snow depths and divide by number of sampling points to obtain average snow depth.
See sample note below.

SCS-708
(8-56)

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State ARIZONA
Drainage Basin Gila
Snow Course FRISCO DIVIDE
Party Geo. Watt - Ken Bonds
Date Feb. 15, 1958

*Description or Number of Course	†Sample Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per-cent	Remarks (See reverse)
	1	2	2					Dry
	2	2 $\frac{1}{2}$	2					
	3	6	5					
	4	3 $\frac{1}{2}$	3					G.D.F.
	5	2	2					
	6	6	5 $\frac{1}{2}$					
	7	8 $\frac{1}{2}$	7					G.D.F.
	8	2	2					
	9	3 $\frac{1}{2}$	2 $\frac{1}{2}$					
	10	5	4 $\frac{1}{2}$					
	11							
Total	(10)	41		18	30.5	12.5	30	
Avg.	10	4.1				1.3		

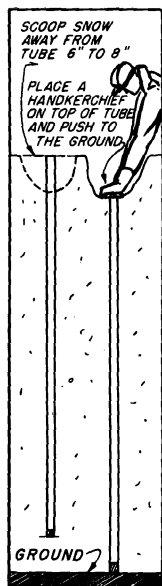
*Show number or description as given on sketch map, i. e., "Course No. 1," or "Major Course," or "N 5° E," etc.

†Always start measurements for sampling from the *initial* point as shown by the sketch map of the course and follow the spacing for samples as indicated. Particular care should be taken to note any *irregular* spacing between samples.

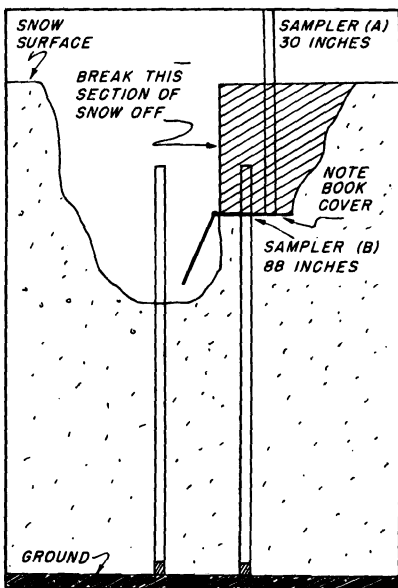
No. 1 of 1 sheets. Comp. by K. Bonds Checked by Watt

Tubes too short for depth of snow

WHEN SNOW DEPTH
IS A FEW INCHES
MORE THAN LENGTH
OF SAMPLERS



WHEN SNOW DEPTH IS CONSIDERABLY
GREATER THAN LENGTH OF SAMPLERS.



If the depth of snow is greater than the length of tubing at hand, follow the procedure below:

1. Drive the tube its full length into the snow.
2. Place a handkerchief or similar object over the top of the tube.
3. Dig down around the tube for a depth of 1 foot or more.
4. Stand on tube and force it down farther.

5. Remove the wadding and observe the depth of the core. When the core has reached the top of the tube, you have reached the limit of this method of measurement.
6. The depth of the snow is the distance from the snow surface to the top of the tube added to the length of tube.

If the snow is too deep to get a whole sample by this method, this second procedure can be used:

1. Dig a hole in the snow at the sampling point to a depth of 2 to 3 feet. Try sampler in bottom of hole. If you have not reached soil, dig deeper. Use a ski heel or tip of snowshoe for a shovel if nothing else is available.
2. Slide a metal plate or firm, flat object (aluminum notebook cover) into side of pit at a depth that is below the top of the grounded sampler.
3. Drive sampler down to metal plate.
4. Measure depth and core of the first section of snow pack.
5. Break off snow into pit down to metal plate.
6. Weigh and record full weight and weight of empty tube. (See sample note, page 32.)
7. Sample from metal plate down to soil. Weigh and add depths and water contents for that sampling point. (See sample note, page 32.)
8. Be sure to fill the hole if the course is to be sampled at a later date. Bring additional sections of sampler tubing for future surveys.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FEDERAL AND STATE
COOPERATIVE SNOW SURVEYS

State OREGON
Drainage Basin Columbia - Willamette
Snow Course HOGG PASS
Party R.A. Work - A.R. Codd - W.T. Frost
Date April 1, 1939

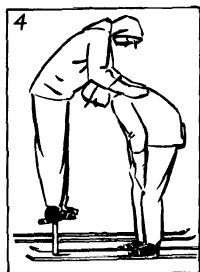
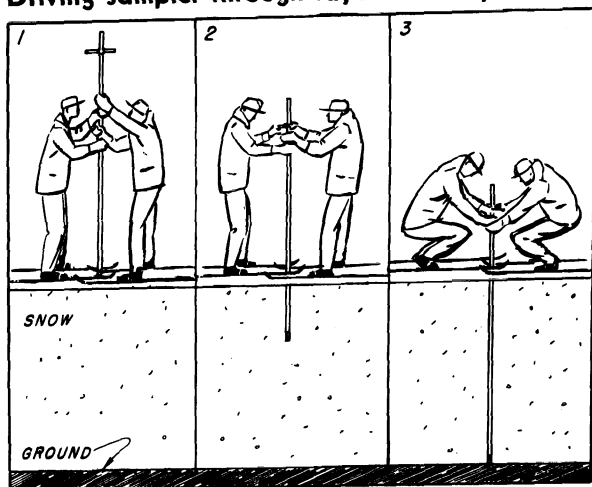
*Description or Number of Course	†Sam- ple Number	Depth of Snow Inches	Length of Core Inches	Weight of Empty Tube	Weight of Tube and Core	Water Content Inches	Density Per- cent	Remarks (See reverse)
<i>Tube too short.</i>	1a	30	29	19	31½	12½	42	G.N.F.
	1b	88	88	19	58	39½	45	Damp.
→	1	118	117			52	44	
	2a	38	36	19	34	15	39	G.N.F.
	2b	86	85	19	55	36	42	Wet
→	2	124	121			51	41	
	3a	22	20	19	28	9	41	G.N.F.
	3b	89	88	19	57	38	43	Grass Damp
	3	111	108			47	42	
Sample of note keeping, for procedure when taking samples in sections.								
Totals are found by adding figures in rows 1, 2, 3 etc.								

*Show number or description as given on sketch map, i. e., "Course No. 1," or "Major Course," or "N 5° E," etc.

†Always start measurements for sampling from the initial point as shown by the sketch map of the course and follow the spacing for samples as indicated. Particular care should be taken to note any irregular spacing between samples.

No. 1 of 3 sheets. Comp. by R.A.W. Checked by A.R.C.

Driving sampler through layers of deep snow



When sampling deep snow, drive the sampler rapidly. Try to keep it moving continuously until soil is reached.

1. Both men get ready—both drive the sampler with a hand over hand motion.
2. Keep the sampler in motion.
3. Grab the handle of the driving wrench and push down.
4. If the tube stops, one man steps on the handles and drives it down to the soil with his body weight and a pumping action of the knees while balancing himself against his partner's shoulders.